HIGH-DENSITY CA-RICH BRINES IN OH-RICH TOPAZ FROM KYANITE QUARTZITE FROM THE SU-LU UHP METAMORPHIC BELT (EASTERN CHINA).

FERRANDO, S.[1], FREZZOTTI, M.L.[2], COMPAGNONI, R.[3]
[1] Dipartimento di Scienze Mineralogiche e Petrologiche, Via Valperga Caluso 35, 10125 Torino.
[2] Dipartimento di Scienze della Terra, Via Laterina 8, 53100 Siena.
[3] Dipartimento di Scienze Mineralogiche e Petrologiche, Via Valperga Caluso 35, 10125 Torino.
E-mail: simona.ferrando@unito.it

Metamorphic OH-rich topaz has been recently reported from kyanite quartzite at Hushan, belonging to the high-pressure (HP) to ultra-high pressure (UHP) eclogite-facies metamorphic belt of Su-Lu, eastern China (Zhang et al., 2002). The stability of this mineral at quartz- and coesite-facies conditions has been confirmed by experimental works (Wunder at al., 1993; Wunder et al., 1999).

Isopleths for the reactions Al-silicate + fluid = topaz, diaspore + quartz = topaz, and diaspore + quartz = fluid + Al-silicate were calculated thermodynamically (Holland, Powell, 1998; Connolly, 1990) by considering both the hydroxyl contents of the topaz and variable $X_{H2O} = H_2O/(H_2O + CO_2)$ in the fluid phase. The stability of the F-OH topaz solid solution series results to be strongly controlled by both P-T conditions and fluid composition. In particular, the topaz stability field is reduced by the CO_2 increase in the fluid phase.

The studied Hushan kyanite quartzite consists of quartz, kyanite, paragonite, OH-rich topaz, accessory rutile, pyrite, zircon, apatite, and rare barite. The presence in kyanite of rare polycrystalline quartz aggregates suggests the former occurrence of coesite. The X_{OH} = OH/(OH+F) ratio in topaz is quite homogeneous and averages 0.28 (Alberico et al., 2002). Peak metamorphic conditions are consistent with climax conditions estimated for the associated eclogites (T = 800 ± 80 °C and P = 3.2 - 4.0 GPa; Zhang et al., 2000). Microstructural relationships clearly indicate that the OH-rich topaz formed at the expense of kyanite during early decompression by a reaction such as: kyanite + fluid = topaz.

OH-rich topaz crystals contain extremely abundant primary (in the sense of Roedder, 1984) fluid inclusions, having rounded or negative crystal shapes. The inclusions, ranging in size from < 5 to 20 μm, are water dominated with minor CO_2 (5 % in volume) and may contain an anhydrite crystal. Evidence of post-trapping changes, such as partial decrepitation, are often observed. Resetted inclusions contain larger CO_2 bubble (CO_2 = 10 to 50% of the inclusion total volume) and in a few rare cases a single chloride crystal.

The aqueous part of the preserved fluid inclusions freezes below –60°C. The eutectic temperature cannot be accurately measured, but at around –45°C a liquid phase is always observed, which suggests the presence of Ca^{2+} in the fluid. The temperature of hydrohalite melting (T_{mhy}) occurs between –37.0 and – 32.0°C with most data at -34.4 °C, and ice final melting temperatures ($T_{m\ ice}$) between –17.0 and –13.0 with most data at -13.7 °C; CO_2 melts (Tm_{CO2}) instantaneously at ≅ -56.6°C, and homogenisation, always to the liquid phase (Th_{LCO2}), is recorded between –5.8 and 9.7 °C. Original trapped fluid composition corresponds to a high-density (1.14 - 1.16 g/cm^3) Ca-rich brine containing minor CO_2 (X_{H2O} = 0.87, X_{CO2} = 0.04, X_{NaCl} = 0.01; X_{CaCl2} = 0.08); mean salinity for the aqueous part of the fluid is 2.5 wt % NaCl and 15 wt % $CaCl_2$ (Bakker, 1999). Resetted inclusions have considerably lower density (1.11 – 0.66 g/cm^3), higher CO_2 content (X_{CO2} = 0.06-0.09) and variable salinity (mean values: 4 wt % NaCl + 11 wt % $CaCl_2$), indicating that some preferential water leakage occurred during decrepitation processes.

The collected data indicate that the fluid phase that assisted the topaz growth at the expense of kyanite was a Ca-dominated medium-salinity brine, containing traces of CO_2. The isochores, calculated from the fluid inclusions with the highest densities (Bakker, 1999), indicate a minimum pressure of 2.8 GPa at the post-climactic temperature of 800°C, estimated from the Su-Lu coesite-eclogite (Nakamura, Hirajima, 2000). The preservation of high-pressure fluid inclusions in microdomains within the topaz crystals, further shows this mineral as a good host for the study of fluid inclusions in high-pressure metamorphic rocks.

A petrogenetic grid, calculated with thermodynamic approach (Holland, Powell, 1998; Connolly, 1990) and considering both topaz (X_{OH} = 0.30) and fluid phase composition (X_{H2O} = 0.90), indicates that the OH-rich topaz grew during the early decompression, at the coesite to quartz transition, on the P-T path estimated for the Su-Lu UHPM rocks (Nakamura, Hirajima, 2000).

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